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☐ 1. Document ID: US 6274013 B1

L1: Entry 1 of 2 File: USPT Aug 14, 2001

US-PAT-NO: 6274013
DOCUMENT-IDENTIFIER: US 6274013 B1

TITLE: Electrode semiconductor workpiece holder

DATE-ISSUED: August 14, 2001

INT-CL: [7] C25 D 17/06

US-CL-ISSUED: 204/297.08; 118/729, 118/503, 204/297.01, 204/297.09, 204/297.1, 204/297.14
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FIELD-OF-SEARCH: 204/297R, 204/297W, 204/280, 204/286, 204/224R, 204/297.01, 204/297.08, 204/297.09, 204/297.1, 204/297.14, 205/123, 118/72B, 118/729, 118/730, 118/500, 118/503, 156/345WH, 269/24, 269/27

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☐ 2. Document ID: US 5980706 A

L1: Entry 2 of 2 File: USPT Nov 9, 1999

US-PAT-NO: 5980706
DOCUMENT-IDENTIFIER: US 5980706 A

TITLE: Electrode semiconductor workpiece holder

DATE-ISSUED: November 9, 1999

INT-CL: [6] C25 D 17/06

US-CL-ISSUED: 204/297R; 118/729, 118/730, 205/123
US-CL-CURRENT: 204/297.14; 118/729, 118/730, 204/297.08, 204/297.1, 205/123

FIELD-OF-SEARCH: 204/297R, 204/297W, 204/280, 204/286, 204/298.15, 204/224R, 118/728, 118/729, 118/730, 118/500, 118/503, 156/345WH, 205/118, 205/122, 205/124, 205/128, 205/136

Full | Title | Citation | Front | Review | Classification | Date | Reference | Sequences | Attachments | Claims | KWIC | Draw Desc | Image

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and disengaged positions is but one manner of effectuating such movement. Other manners of effectuating such movement are possible.

The invention also includes novel methods for presenting a workpiece to a semiconductor process. In such methods, a workpiece is first secured to a workpiece holder. The methods work equally well for workpiece holders known in the art and for the novel workpiece holders disclosed herein.

In the next step in the sequence, the workpiece holder is rotated about a horizontal axis from an initial or first position where the workpiece holder was provided with the workpiece to a second position. The second position will be at an angle to the horizontal. The angle of the workpiece holder to the horizontal is defined by the angle between the plane of the workpiece and the horizontal. In the method, the workpiece holder is advantageously suspended about a second horizontal axis which is parallel to the first horizontal axis of the workpiece holder. At this point in the method, the angle between the first and second horizontal axes and a horizontal plane corresponds to the angle between the workpiece holder and the horizontal. The workpiece holder is then pivoted about the second horizontal axis to move the workpiece and the workpiece holder from its initial location to a final location in a horizontal plane. Advantageously, when the workpiece holder is pivoted about the second horizontal axis, the first horizontal axis also pivots about the second horizontal axis.

Preferably, during the step of rotating the workpiece holder about the first horizontal axis, the angle of the workpiece holder with respect to some known point, which is fixed with respect to the workpiece holder during the rotation process, is continually monitored. Monitoring allows for precise positioning of the workpiece holder with respect to the horizontal surface.

Likewise, during pivoting of the workpiece holder about the second horizontal axis, it is preferable that the angle defined by the line connecting the first and second horizontal axes and the horizontal plane be continually monitored. In this manner, the absolute position of the workpiece holder (and hence the workpiece itself) will be known with respect to the horizontal plane. This is important since the horizontal plane typically will contain the process to which the workpiece will be exposed.

It should be noted that in the above and following description, while the workpiece is described as being presented to a horizontal plane, it is possible that the workpiece may also be presented to a vertical plane or a plane at any angle between the vertical and the horizontal. Typically, the processing plane will be a horizontal plane due to the desire to avoid gravitational effects on process fluids to which the workpiece is exposed. In one embodiment after the workpiece has been presented to the processing plane, the workpiece holder is rotated about a spin axis to cause the workpiece to spin in the horizontal plane. Although not required in all semiconductor manufacturing processes, this is a common step which may be added in the appropriate circumstance.

The next advantageous step in the method consists of pivoting the workpiece holder about the second horizontal axis back along the path that the workpiece holder was initially pivoted along when presenting the workpiece to the horizontal process plane. There is no requirement that the workpiece holder be pivoted back to the same position whence it began, although doing so may have certain advantages as more fully described below.

The method advantageously further consists of the step of rotating the workpiece holder about the first horizontal axis to return the workpiece to the position when it was initially presented to and engaged by the workpiece holder. It is advantageous to rotate the workpiece holder about the first axis in a direction opposite from the initial rotation of the workpiece holder.

The advantage of having the workpiece holder terminate at an end position which corresponds to the initial position when the workpiece was loaded into the workpiece holder is efficiency. That is, additional machine movements are not required to position the workpiece holder to receive a new workpiece.

The method more preferably includes the step of rotating the workpiece holder about the first horizontal axis at at least two support points along the first horizontal axis. This beneficially provides support and stability to the workpiece holder during the rotation process and subsequent movement of the apparatus.

The method also more preferably includes the step of pivoting the workpiece holder along with the first horizontal axis about the second horizontal axis at at least two support points along the second horizontal axis. This beneficially provides additional support for the workpiece holder while allowing the workpiece holder to be moved in a vertical or "Z-axis" direction.

Importantly, the only motion described in the above method is rotational motion about several axes. In the method described, there is no translational motion of the workpiece holder in a X-, Y-, or Z-axis without corresponding movement in another axis as a result of rotating through an arc.

In compliance with the statute, the invention has been described in language more or less specific as to structural and methodical features. It is to be understood, however, that the invention is not limited to the specific features shown and described, since the means herein disclosed comprise preferred forms of putting the invention into effect. The invention is, therefore, claimed in any of its forms or modifications within the proper scope of the appended claims appropriately interpreted in accordance with the doctrine of equivalents.

We claim:

1. A workpiece holder for use in processing a workpiece comprising:

a movable workpiece support mounted for movement between a processing position which is used to support a workpiece in position for processing and an open position wherein the workpiece support is open and available for loading and unloading a workpiece to and from the workpiece support;

at least one finger assembly mounted upon said movable workpiece support, said at least one finger assembly including at least one electrode having an electrode contact for contacting a surface of said workpiece to provide electrical connection therewith;

at least one finger actuator operable with said at least one finger assembly for moving said finger assembly between an engaged position wherein said finger assembly is in contact with the workpiece and a disengaged position wherein said finger assembly is disengaged from the workpiece, said at least one finger actuator having means for moving the at least one finger assembly in an axial movement toward and from the workpiece and means to rotate the at least one finger assembly in a rotational movement.

2. The workpiece holder of claim 1 wherein said at least one finger actuator moves said at least one finger assembly in a reciprocal manner.

3. The workpiece holder of claim 1, wherein said means to rotate the at least one finger assembly rotates the finger assembly about a pivot axis which is aligned with the axial movement produced by said means for moving the at least one finger assembly in an axial movement.

4. The workpiece holder of claim 1 further comprising at least one protective sheath covering at least a portion of the at least one finger assembly to protect the finger assembly from contact with a plating fluid, said at least one protective sheath being made from a dielectric material.

5. The workpiece holder of claim 4, wherein said at least one protective sheath includes a rim portion for engaging said workpiece and forming a seal therebetween.

6. The workpiece holder of claim 4, wherein said electrode contact is maintained in a generally retracted position within said at least one protective sheath when said at least one finger assembly is in said disengaged position; said electrode contact being moved out of said retracted position when said at least one finger assembly is moved into said engaged position.

7. The workpiece holder of claim 4, wherein said at least one protective sheath includes a yieldable terminal end adjacent said electrode contact for engaging said workpiece and effectively sealing said electrode contact therewithin when said at least one finger assembly is moved to said engaged position; wherein said electrode contact is maintained in a generally retracted position within said at least one protective sheath when said at least one finger assembly is in said disengaged position; said electrode contact being moved out of said retracted position when said finger assembly is moved into said engaged position.

8. The workpiece holder of claim 1, wherein said at least one finger assembly comprises:

a finger assembly frame;

a collet movably mounted on said finger assembly frame for longitudinal reciprocation into and out of said engaged position;

a finger secured to said collet and movable thereby, a portion of said finger extending generally away from said collet; and

a bend in said finger between said collet and said contact.

9. The workpiece holder of claim 1, wherein said movable workpiece support includes a rotor operatively mounted for rotation about a rotor axis; said rotor moving said workpiece about said rotor axis for processing.

10. The workpiece holder of claim 1, wherein:

said movable workpiece support includes a rotor operatively mounted for rotation about a rotor axis; said rotor rotating said workpiece for processing; and

there are plural finger assemblies and plural finger actuators.

11. A workpiece holder for use in a plating process to hold and provide electrical contact with a workpiece, comprising:

a movable workpiece support mounted for powered movement between a processing position wherein the workpiece support is placed in relationship with a processing bowl, and an open position wherein the workpiece support is removed from the processing bowl and available for loading and unloading a workpiece to and from the workpiece support;

a workpiece support operator for powering movement of the movable workpiece support between said processing position and said open position;

a rotor mounted for rotational movement upon the movable workpiece support to allow the workpiece support and a workpiece supported thereon to be rotated during processing;

at least one finger assembly mounted upon said rotor, said at least one finger assembly including at least one contact for contacting the workpiece;

at least one finger actuator mounted upon the movable workpiece support, said at least one finger actuator being controllably movable to effect movement of the at least one finger assembly between an engaged position wherein the at least one finger assembly engages the workpiece and a disengaged position wherein the at least one finger assembly is disengaged from the workpiece to allow the workpiece to be loaded and unloaded from the workpiece support;

at least one electrode forming a part of said at least one finger assembly, said at least one electrode having an electrode contact for contacting a surface of said workpiece to provide electrical connection therewith, wherein said electrode contact is one of said at least one contact.

12. A workpiece holder according to claim 11 wherein there are a plurality of finger assemblies and finger actuators.

13. A workpiece holder according to claim 11 wherein said at least one finger actuator is controllably engaged and disengaged with the at least one finger assembly mounted upon the rotor.

14. A workpiece holder according to claim 11 wherein said at least one finger actuator includes means for moving the at least one finger assembly in an axial movement toward and from the workpiece.

15. A workpiece holder according to claim 11 wherein said at least one finger actuator includes means to rotate the at least one finger assembly in a rotational movement.

16. A workpiece holder according to claim 11 wherein said at least one finger actuator includes means for moving the at least one finger assembly in an axial movement toward and from the workpiece and means to rotate the at least one finger assembly in a rotational movement.

17. A workpiece holder according to claim 11 and further comprising at least one protective sheath covering at least a portion of the at least one finger assembly to protect the finger assembly from contact with a plating fluid, said at least one protective sheath being made from a dielectric material.

18. A workpiece holder according to claim 17 wherein there are a plurality of finger assemblies and finger actuators.

19. A workpiece holder according to claim 17 wherein said at least one protective sheath includes a rim portion for engaging said workpiece and forming a seal therebetween.

20. A workpiece holder according to claim 17 wherein said electrode contact is maintained in a generally retracted position within said at least one protective sheath when said at least one finger assembly is in said disengaged position; said electrode contact being moved out of said retracted position when said at least one finger assembly is moved into said engaged position.

21. A workpiece holder according to claim 17 wherein said at least one protective sheath includes a yieldable terminal end adjacent said electrode contact for engaging said workpiece and effectively sealing said electrode contact therewithin when said at least one finger assembly is moved to said engaged position; wherein said electrode contact is maintained in a generally retracted position within said at least one protective sheath when said at least one finger assembly is in said disengaged position; said electrode contact being moved out of said retracted position when said finger assembly is moved into said engaged position.

* * * * *

The above described pneumatically effectuated movement of the preferred finger assemblies between the engaged and disengaged positions is but one manner of effectuating such movement. Other manners of effectuating such movement are possible.

The invention also includes novel methods for presenting a workpiece to a semiconductor process. In such methods, a workpiece is first secured to a workpiece holder. The methods work equally well for workpiece holders known in the art and for the novel workpiece holders disclosed herein.

In the next step in the sequence, the workpiece holder is rotated about a horizontal axis from an initial or first position where the workpiece holder was provided with the workpiece to a second position. The second position will be at an angle to the horizontal. The angle of the workpiece holder to the horizontal is defined by the angle between the plane of the workpiece and the horizontal. In the method, the workpiece holder is advantageously suspended about a second horizontal axis which is parallel to the first horizontal axis of the workpiece holder. At this point in the method, the angle between the first and second horizontal axes and a horizontal plane corresponds to the angle between the workpiece holder and the horizontal. The workpiece holder is then pivoted about the second horizontal axis to move the workpiece and the workpiece holder from its initial location to a final location in a horizontal plane. Advantageously, when the workpiece holder is pivoted about the second horizontal axis, the first horizontal axis also pivots about the second horizontal axis.

Preferably, during the step of rotating the workpiece holder about the first horizontal axis, the angle of the workpiece holder with respect to some known point, which is fixed with respect to the workpiece holder during the rotation process, is continually monitored. Monitoring allows for precise positioning of the workpiece holder with respect to the horizontal surface.

Likewise, during pivoting of the workpiece holder about the second horizontal axis, it is preferable that the angle defined by the line connecting the first and second horizontal axes and the horizontal plane be continually monitored. In this manner, the absolute position of the workpiece holder (and hence the workpiece itself) will be known with respect to the horizontal plane. This is important since the horizontal plane typically will contain the process to which the workpiece will be exposed.

It should be noted that in the above and following description, while the workpiece is described as being presented to a horizontal plane, it is possible that the workpiece may also be presented to a vertical plane or a plane at any angle between the vertical and the horizontal. Typically, the processing plane will be a horizontal plane due to the desire to avoid gravitational effects on process fluids to which the workpiece is exposed. In one embodiment after the workpiece has been presented to the processing plane, the workpiece holder is rotated about a spin axis to cause the workpiece to spin in the horizontal plane. Although not required in all semiconductor manufacturing processes, this is a common step which may be added in the appropriate circumstance.

The next advantageous step in the method consists of pivoting the workpiece holder about the second horizontal axis back along the path that the workpiece holder was initially pivoted along when presenting the workpiece to the horizontal process plane. There is no requirement that the workpiece holder be pivoted back to the same position whence it began, although doing so may have certain advantages as more fully A described below.

The method advantageously further consists of the step of rotating the workpiece holder about the first horizontal axis to return the workpiece to the position when it was initially presented to and engaged by the workpiece holder. It is advantageous to rotate the workpiece holder about the first axis in a direction opposite from the initial rotation of the workpiece holder.

The advantage of having the workpiece holder terminate at an end position which corresponds to the initial position when the workpiece was loaded into the workpiece holder is efficiency. That is, additional machine movements are not required to position the workpiece holder to receive a new workpiece.

The method more preferably includes the step of rotating the workpiece holder about the first horizontal axis at at least two support points along the first horizontal axis. This beneficially provides support and stability to the workpiece holder during the rotation process and subsequent movement of the apparatus.

The method also more preferably includes the step of pivoting the workpiece holder along with the first horizontal axis about the second horizontal axis at at least two support points along the second horizontal axis. This beneficially provides additional support for the workpiece holder while allowing the workpiece holder to be moved in a vertical or "Z-axis" direction.

Importantly, the only motion described in the above method is rotational motion about several axes. In the method described, there is no translational motion of the workpiece holder in a X-, Y-, or Z-axis without corresponding movement in another axis as a result of rotating through an arc.

In compliance with the statute, the invention has been described in language more or less specific as to structural and methodical features. It is to be understood, however, that the invention is not limited to the specific features shown and described, since the means herein disclosed comprise preferred forms of putting the invention into effect. The invention is, therefore, claimed in any of its forms or modifications within the proper scope of the appended claims appropriately interpreted in accordance with the doctrine of equivalents.

What is claimed is:

1. A workpiece holder for use in processing a workpiece comprising:

a workpiece support;

at least one finger assembly mounted upon said workpiece support, said at least one finger assembly including at least one contact for contacting the workpiece;

at least one finger actuator operable with said at least one finger assembly for moving said finger assembly between an engaged position wherein said finger assembly is in contact with the workpiece and a disengaged position wherein said finger assembly is disengaged from the workpiece, said at least one finger actuator having means for moving the at least one finger assembly in an axial movement toward and from the workpiece along a longitudinal axis, and means to rotate the at least one finger assembly in a rotational movement along said longitudinal axis;

at least one electrode forming a part of said at least one finger assembly, said at least one electrode having an electrode contact for contacting a surface of said workpiece to provide electrical connection therewith, wherein said electrode contact is one of said at least one contact;

at least one protective sheath covering at least a portion of the at least one finger assembly to protect the finger

assembly from contact with a plating fluid, said at least one protective sheath being made from a dielectric material, said electrode contact being maintained in a generally retracted position within said at least one protective sheath when said at least one finger assembly is in said disengaged position, said electrode contact being moved out of said retracted position when said at least one finger assembly is moved into said engaged position.

2. The workpiece holder of claim 1 wherein said at least one finger actuator moves said at least one finger assembly in a reciprocal manner.

3. A workpiece holder for use in processing a workpiece comprising:

a workpiece support;

at least one finger assembly mounted upon said workpiece support, said at least one finger assembly including at least one contact for contacting the workpiece;

at least one finger actuator operable with said at least one finger assembly for moving said finger assembly between an engaged position wherein said finger assembly is in contact with the workpiece and a disengaged position wherein said finger assembly is disengaged from the workpiece, said at least one finger actuator having means for moving the at least one finger assembly in an axial movement toward and from the workpiece along a longitudinal axis, and means to rotate the at least one finger assembly in a rotational movement along said longitudinal axis;

at least one electrode forming a part of said at least one finger assembly, said at least one electrode having an electrode contact for contacting a surface of said workpiece to provide electrical connection therewith, wherein said electrode contact is one of said at least one contact;

at least one protective sheath covering at least a portion of the at least one finger assembly to protect the finger assembly from contact with a plating fluid, said at least one protective sheath being made from a dielectric material, said at least one protective sheath including a yieldable terminal adjacent said electrode contact for engaging said workpiece and effectively sealing said electrode contact therewith when said at least one finger assembly is moved to said engaged position said electrode contact being maintained in a generally retracted position within said at least one protective sheath when said at least one finger assembly is in said disengaged position, said electrode contact being moved out of said retracted position when said finger assembly is moved into said engaged position.

4. An apparatus for use in providing electrical power to a substrate while a surface of the substrate is in contact with an electrolyte pursuant to forming one or more microelectronic components on the substrate, the apparatus comprising:

one or more substrate support surfaces positioned to support the substrate as the substrate is received by or removed from the apparatus;

a contact assembly comprising

a contact actuator,

a contact member having a first end connected for actuation by the contact actuator and a second end terminating at an electrode, the contact actuator being operable to move the contact member between a first position distal the one or more substrate support surfaces to thereby allow the substrate to be received by or removed from engagement with the one or more substrate support surfaces and a second position in which the electrode is driven into electrical contact with the surface of the substrate that is to contact the electrolyte;

a dielectric sheath disposed proximate the second end of the contact member, the dielectric sheath terminating at a yieldable portion that extends beyond the electrode when the contact member is in the first position so that the electrode is retracted within a volume defined by the yieldable portion, the yieldable portion resiliently deforming when the contact member is moved to the second position, the resilient deformation being sufficient to allow the electrode to extend into electrical contact with the surface of the substrate while concurrently allowing the second end of the dielectric sheath to form a seal with the substrate to prevent the electrode from contacting the electrolyte during substrate processing.

5. The apparatus of claim 4 wherein the contact actuator moves the contact member linearly along and rotationally about a single motion axis when the contact member is moved between the first and second positions.

6. The apparatus of claim 4 wherein the one or more support surfaces are formed by a plurality of support members.

7. The apparatus of claim 4 wherein the apparatus comprises a plurality of contact assemblies.

8. The apparatus of claim 7 wherein the one or more support surfaces are formed by a plurality of support members respectively associated with each of the plurality of contact assemblies.

9. The apparatus of claim 8 wherein the plurality of support members are positioned so that the support surfaces are disposed adjacent the second end of the respective contact member when the contact member is in the second position thereby causing the substrate to be gripped therebetween during processing of the substrate.

10. The apparatus of claim 4 wherein the contact assembly and the one or more support surfaces are mounted to a common frame and extend therefrom in the same direction.

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1			US 6461494 B1	20021008	58	Methods for plating semiconductor workpieces	205/123	204/297.08; 205/143;		Batz, Jr., Robert W. et al.								US
2			US 6454926 B1	20020924	61	Semiconductor plating system workpiece support having	205/96	204/224R; 204/290.11;		Ritzdorf, Thomas L. et al.								US
3			US 6358388 B1	20020319	59	Plating system workpiece support having	205/118	204/224R; 204/286.1;		Bleck, Martin C. et al.								US
4			US 6274013 B1	20010814	33	Electrode semiconductor workpiece holder	204/297.08	118/503; 118/729;		Bleck, Martin et al.								US
5			US 6001234 A	19991214	59	Methods for plating semiconductor workpieces	205/123	205/143; 205/291		Batz, Jr., Robert W. et al.								US
6			US 5985126 A	19991116	60	Semiconductor plating system workpiece support having	205/123	204/224R; 204/288.1;		Bleck, Martin C. et al.								US
7			US 5980706 A	19991109	33	Electrode semiconductor workpiece holder	204/297.14	118/729; 118/730;		Bleck, Martin et al.								US

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